SHOOT AND FOLIAGE PRODUCTION OF FIVE SHRUB SPECIES OF *ACACIA* AND *HAKEA* IN A DRY SCLEROPHYLL FOREST

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Summary

Maconochie, J. R. (1975).—Shoot and foliage production of five shrub species of *Acacia* and *Hakea* in a dry sclerophyll forest. *Trans. R. Soc. S. Aust.* **99**(4), 177-181, 30 November, 1975.

An examination has shown that shoot growth of *Acacia myrtifolia*, *A. pycnantha*, *Hakea rostrata*, *H. rugosa* and *H. ulicina* is distinctly seasonal. Growth commenced in spring, finished by mid-summer and was preceded by flowering.

The maximum rates of loss of foliage occurred towards the cessation of active shoot growth and both mature and juvenile foliage was lost. Measurements of size of shoots of the three species of *Hakea* over a series of years suggested that the available soil moisture during the growth period was the controlling factor for shoot size. It is further suggested that the growth habit of these three species is reflected in the pattern and size of new shoots along a parent shoot. *H. ulicina*, the species which showed a tendency toward apical dominance is an erect, several stemmed shrub, whereas *H. rostrata* and *H. rugosa* are rounded spreading shrubs.

Introduction

This study on shoot production of the five temperate shrubs, *Acacia myrtifolia* (Sm.) Willd., *A. pycnantha* Benth., *Hakea rostrata* F. Muell. ex Meisn., *H. rugosa* R. Br. and *H. ulicina* R. Br., was part of a project in which shoot growth was measured on other shrubs from the arid and semi-arid areas of South Australia (Maconochie & Lange 1970, Maconochie 1973), to obtain basic phenological data in a range of habitats.

Study Site and Methods

This study was carried out on the boundary of the Para Wirra Reserve in the Mt Lofty Ranges, South Australia from April 1965 until January 1967. The occurrence and size of new shoots produced on about 120 tagged shoots of each species of *Hakea* and *A. pycnantha*, and of 25 tagged shoots on two bushes of *A. myrtifolia*, were recorded monthly. The technique has been described previously (Maconochie & Lange 1970).

From 1965 until 1971, samples of shoots were collected at the end of the growing season from the three *Hakea* species and data recorded on size and position of new shoots. These data for axillary and terminal shoots were separated and the annual mean shoot sizes compared by analysis of variance.

Climatic data were supplied by the Australian Bureau of Meteorology.

Results

Qualitative Aspects

The percentage cumulative gains and losses of foliage for *A. pycnantha* and *A. myrtifolia* are presented in Fig. 1. *A. myrtifolia* did not produce any new shoots in the first year of the study but the burst of growth during the second year was in phase with that of *A. pycnantha*. The "stepped" effect displayed by *A. pycnantha* was also produced by *H. rostrata*, *H. rugosa* and *H. ulicina*. New shoot growth was distinctly seasonal.

Figure 2 presents the relative rates of gain and loss for the five species. Climatic data are presented in Fig. 3; soil moisture values were taken from Martin & Specht (1962).

Shoot growth reached a peak during October when daily temperatures were increasing and soil moisture was available (Figs 2 and 3). In both 1965 and 1966, flowering, which commenced in early August and finshed by the

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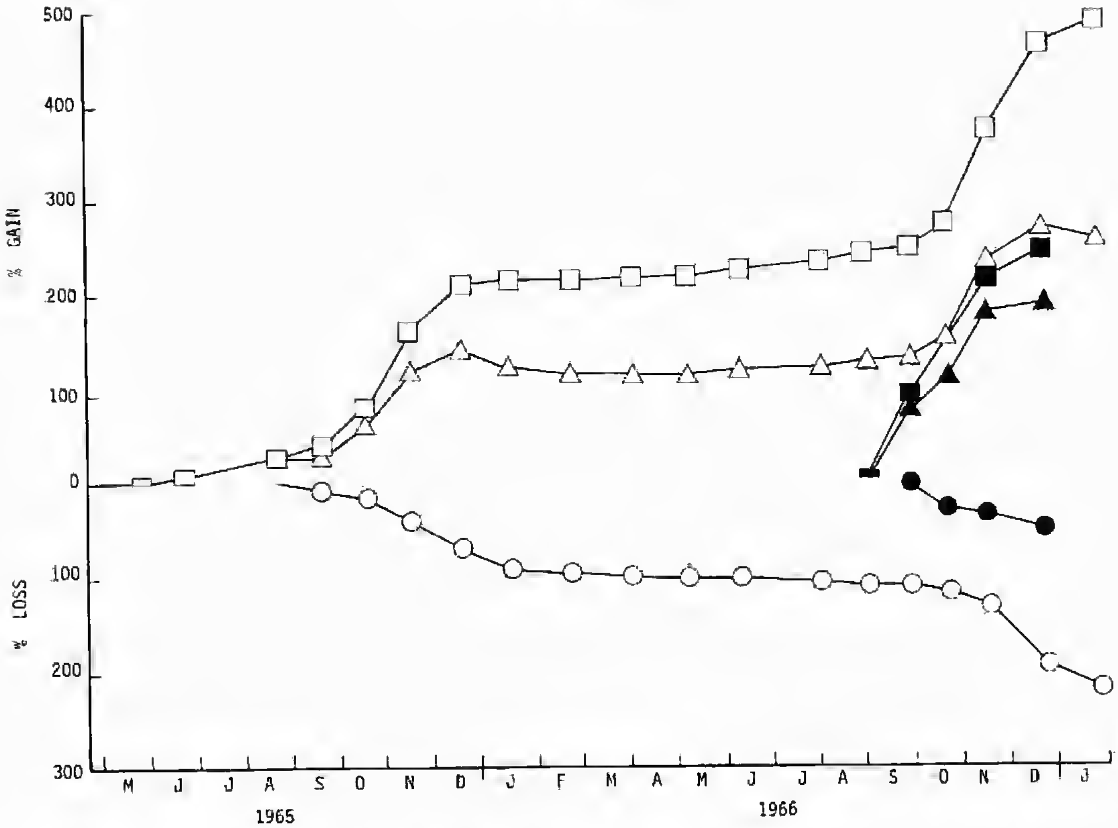

Fig. 1. The percentage cumulative leaf gain and loss of *A. pycnantha* (□, total new positions; △, leaves; ○, scars), and *A. myrtifolia* (■, new positions; ▲, leaves; ●, scars).

end of September, preceded shoot growth. Immature flower buds on the *Acacia* species were observed to develop as early as January. Both axillary and terminal flower and shoot buds on the *Hakea* species were enclosed in bracts and these buds developed as the new leaves matured. This observation suggested that the size of new shoots for the next season may be predetermined by conditions at the time of bud development.

Although the *A. myrtifolia* bushes did not produce new shoots in 1965, flowering did take place.

The peaks in rates of foliage loss coincided with or immediately followed the peaks of production, with loss comprising both mature senescing and soft immature foliage. Some further loss was caused during a severe wind and hail storm in December 1966 in which trees and branches were felled, and also by bird pruning during July-August 1966. Parrots were observed pruning all the trees and tall shrubs, apparently at random, in the area and in some cases clipping off branches up to 5 mm thick.

Some losses of *H. ulicina* and *H. rostrata* during January-February 1966 were a result of the death of several plants. These bushes were not examined for cause of death, but since rainfall in 1965 was 223 mm below average it is probable that localised drought during summer was the most likely cause of death.

Generally once new foliage had matured, the rate of leaf loss on the *Hakea* species declined to almost zero. The needle-like, rigid, sclerophyllous leaves of these species are obviously more resistant to physical damage than the leaves of the more mesomorphic species of the community.

Quantitative Aspects

The mean number of leaves per shoot for each species and for the years 1965 to 1971 inclusive are presented in Table 1. Analysis of these data showed that for some years

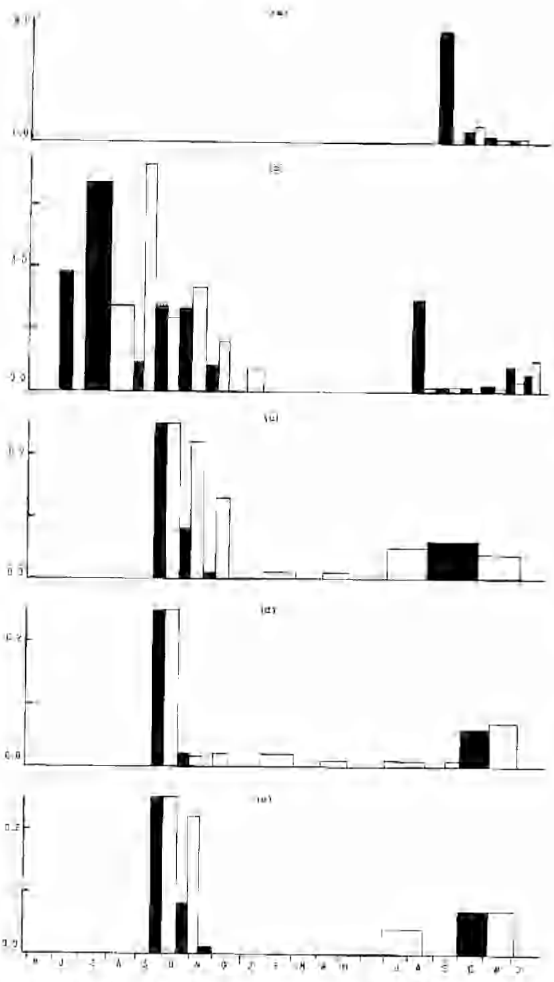

Fig. 2. The relative rates of gain (block) and loss of foliage of (a) *A. myrtifolia*, (b) *A. pycnantha*, (c) *H. ulicina*, (d) *H. rostrata*, and (e) *H. rugosa*, for the years 1965 and 1966.

there was a significant difference between the sizes of shoots produced in successive years. In other years, the variation in shoot size was so large that no significance could be attached to the differences.

A set of correlation coefficients (r) and regression equations were computed between total rainfall (x) for the period September to November and the mean shoot sizes (y) for successive years during which there were significant differences ($P<.05$) between the means. This rainfall period was selected because it was the time of active growth.

H. ulicina—axillary shoots

$r = + 0.74 \quad 0.10 > P > .05$
$y = \quad 5.0 + 0.014x$

H. rostrata—terminal and axillary shoots

$r = + 0.52 \quad P > 0.10$
$y = \quad 5.1 + 0.008x$

H. rugosa—terminal and axillary shoots

$r = + 0.83 \quad .05 > P > .02$
$y = \quad 4.1 + 0.029x$

H. rugosa was the only species showing an acceptably significant correlation between mean shoot size and rainfall during the growing season.

Calculation of the correlation coefficient between the mean shoot size and rainfall period September-November of the preceding year gave the following: *H. ulicina*—0.65, *H. rostrata*—0.07, and *H. rugosa*—0.55.

Analysis of the data for 1966 on the relative positions of shoots showed that there were no significant differences in shoot sizes between pairs of positions distal to the apex (Table 2) except for *H. ulcina*. In this species there was a significant difference ($P < 0.05$) between the mean of the terminal and that of the first axillary position. Further analysis showed significant differences ($P < 0.05$) between terminal and axillary positions two and three. It would appear, therefore, that *H. ulicina* is the only one of these three species which has a tendency towards apical dominance.

Discussion

Cambage (1918, 1927) measured the height growth of *A. pycnantha* at Sydney Botanic Gardens and his study showed the normal pattern of rapid growth during the juvenile stage followed by a decreasing rate as the plant matured. The plants studied at Para Wirra were mature and the rates of growth as reflected in both Figs 1 and 2 were of a "steady state" nature, as occurs at the plateau of the sigmoid growth curve.

Martin & Specht (1962) measured the moisture relationships in a dry sclerophyll forest, of which these species are shrub components. Their studies showed that the more mesic community of this vegetation type had a higher index of evapotranspiration and could be subjected to a drought period during the mid-summer. The three species of *Hakea* and two *Acacia* species all show a distinct seasonality of shoot growth with a cessation occurring in mid-summer probably during the drought period or when soil moisture is only sufficient to maintain a dormant growth phase.

The negative correlation between mean shoot size and soil moisture (as reflected by

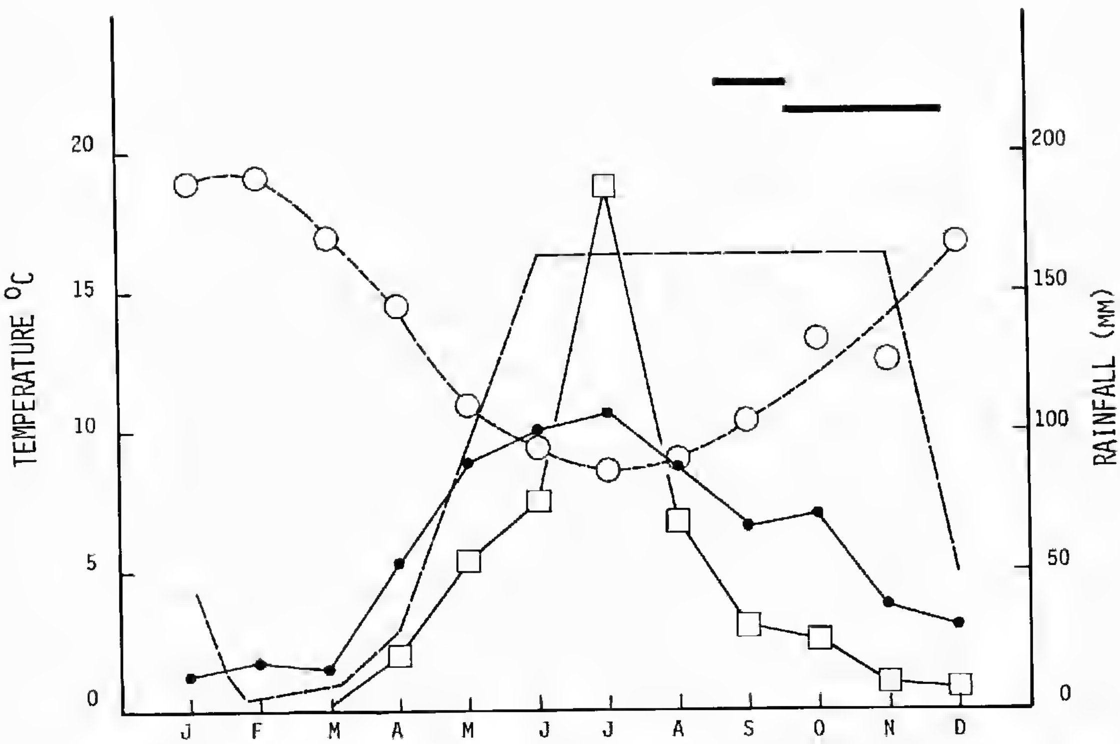

Fig. 3. Climatic data of Parra Wirra study site; soil moisture ex Martin & Specht (1962), other data means for 1965-1970. ——, soil moisture; ○, mean temperature; —·—, rainfall; □, potential evapotranspiration (P/E 0.75); ———, florescence and duration of active growth.

TABLE 1

Mean number of leaves per shoot for seasons 1965 to 1971

Species	Shoot Posn.	1965	1966	1967	Year 1968	1969	1970	1971
Hakea ulicina	Total	7.4*	8.1*	8.2	8.7	9.2	9.4	9.8
	Terminal	9.6	10.2	9.4*	9.4	10.9	10.6	11.2
	Axillary	5.9†	7.1†	4.9‡	8.1*	6.7†	8.9	8.4
Hakea rostrata	Total	6.4†	5.8†	5.2	5.4‡	6.5	6.7‡	9.0
	Terminal	6.1	6.1	5.7	5.4‡	7.0	6.5‡	10.6
	Axillary	6.5‡	5.7	5.2	5.4‡	6.4	6.8*	7.5
Hakea rugosa	Total	7.2‡	9.1‡	4.6‡	8.7	8.4†	9.2‡	13.7
	Terminal	7.3‡	9.4	8.1	8.8	8.8	9.5‡	15.9
	Axillary	6.9‡	9.0‡	4.4‡	8.8	8.3*	8.9‡	12.7

Significant differences between mean and mean of succeeding year are indicated.
* $P < 0.05$; † $P < 0.01$; ‡ $P < .001$.

TABLE 2

Mean number of leaves per shoot for terminal and axillary positions distal from shoot tip for year 1966

Relative Position	Term.	AX_1	AX_2	AX_3	AX_4	AX_5	AX_6	AX_7	AX_8
H. ulicina	10.9*	7.8	7.5	7.2	7.6	7.4	6.6	7.6	5.6
H. rostrata	6.2	6.0	5.3	5.6	5.3	5.3			
H. rugosa	9.3	8.6	9.6	10.2	10.3	8.2			

* Indicates significant difference ($.05 > P > .01$) between mean and that of succeeding position.

rainfall) during the growing period of the previous year suggests that shoot size in the following year is not necessarily determined at the bud formation stage. Rather these results suggest that shoot size is more likely to be determined by the soil moisture during the period of active growth.

The time of shoot growth for these species contrasts with that of heath studies of Specht (1957), Specht & Rayson (1957) and Groves (1965), who recorded that the shoot growth commenced in December when soil moisture was decreasing. Specht (1957) showed that drought conditions occurred in both December and January. Groves (1965) noted that shoot-growth continued throughout the summer of his study period; however a recharge of soil moisture from a mid-summer rain was recorded.

Maconochie & Lange (1970) and Maconochie (1973) have reported the seasonality of shoot growth on *A. sowdenii*, *A. ligulata* and *A. murrayana*, and possible non-seasonal and seasonal shoot growth responses on *A. aneura* and *A. kempeana*. Wetherell (1966) recorded flushes of growth on *A. harpophylla* in Queensland during spring and summer, and during one period of early winter. *A. pycnantha*, by contrast, actively grew only during the spring period at the study site, and although shoot growth on *A. myrtifolia* was only recorded during the second year, it appears that from this slender evidence that the shoot growth follows a seasonal pattern also.

Both *H. rostrata* and *H. rugosa* have a more spreading bushy habit than *H. ulicina* which has a tendency to be more erect. The habit of these plants is reflected in the sizes of new shoots on a parent shoot. Both *H. rostrata* and *H. rugosa* did not produce significantly smaller axillary shoots in comparison to the terminal, but the terminal shoots of *H. ulicina* were significantly larger than shoots on the three succeeding positions below the apex. This suggests a tendency towards apical dominance and thus explains the more erect habit of this species.

Acknowledgments

The author is indebted to Dr R. T. Lange, Botany Department, University of Adelaide, for his encouragement in the first part of the project. Dr R. W. Rogers, now of the University of Queensland, supplied samples during the years 1967 to 1970 and his assistance is gratefully acknowledged.

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